Chesapeake Executive Council

Comprehensive Research Plan

Chesapeake Bay Program

Agreement Commitment Report

July 1988

Comprehensive Research Plan

An Agreement Commitment Report from the Chesapeake Executive Council

Annapolis, Maryland
July 1988

ADOPTION STATEMENT

We, the undersigned, adopt the **Comprehensive Research Plan**, in fulfillment of Governance Commitment Number 4 of the 1987 Chesapeake Bay Agreement:

> *"...by July 1988, to develop and adopt a comprehensive research plan to be evaluated and updated annually to address the technical needs of the Chesapeake Bay Program."*

We direct the Implementation Committee and the Scientific and Technical Advisory Committee to establish a standing Research Planning Committee, as detailed in the document, to initiate planning for a Chesapeake Bay Research Directory, an annual assessment of the Bay Program's research achievements, and the periodic review and modification of research priorities as necessary.

The process described in this document will be used to plan the research components of the annual budgets of Bay management and planning agencies. It will also serve as the basis for developing the longer-term studies necessary for continued improvement in our understanding of the Chesapeake Bay and its living resources. We recognize that a strong research component of the Chesapeake Bay Program is necessary to provide the information upon which protection and restoration strategies and programs can be based.

The Research Planning Committee will annually report to the Executive Council on research efforts supported by the Bay Program. In addition to reviewing the scientific and technical findings, this report will identify potential management implications of these findings. The research report will also be incorporated into the annual report of the Chesapeake Bay Program.

For the Commonwealth of Virginia

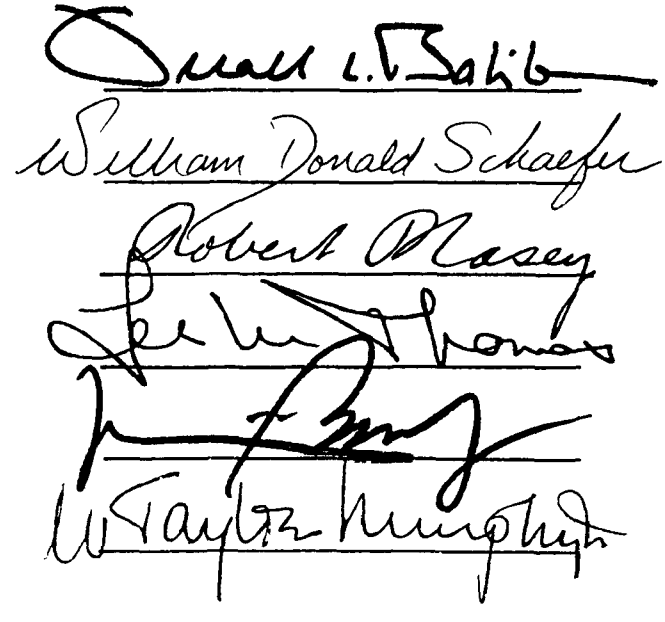
For the State of Maryland

For the Commonwealth of Pennsylvania

For the United States of America

For the District of Columbia

For the Chesapeake Bay Commission



PREAMBLE

The signers of the Chesapeake Bay Agreement of 1987, recognizing the importance of research to the Chesapeake Bay Restoration and Protection Program, called for the development of a comprehensive research plan. The Scientific and Technical Advisory Committee (STAC) volunteered to take the lead in developing this plan. The STAC formed a Research Plan Development Committee consisting of representatives from Bay research institutions, federal and state management or policy agencies, and a representative of the Citizens Advisory Committee.

The Committee solicited wide input to the research plan through two mechanisms.

a) Distribution of over 350 questionnaires to scientists and resource managers throughout the Bay region. These questionnaires solicited specific recommendations for research or statements of information needs specific to the objectives and commitments in the 1987 Chesapeake Bay Agreement.

b) A research conference held in Baltimore, Maryland on 29-31 March 1988 which reviewed our understanding of estuarine processes in several areas critical to the Bay management efforts.

In addition, many institutions provided documents on detailed research needs, research plans, and management issues. Committee members reviewed these and other published statements of research needs and research plans developed for Chesapeake Bay and other estuarine and coastal areas.

The responses to the questionnaires were reviewed by the Committee and compiled into a statement of specific research needs related to specific objectives and commitments of the 1987 Bay Agreement. These research specific questions were also reviewed to develop more generic questions related to fundamental processes.

The Committee used the results of this effort as well as insight gained from the research conference and conference background material to develop a draft research plan and a draft set of research priorities. After public and agency review, the Committee met and revised the document.

ACKNOWLEDGEMENTS

Numerous resource managers, researchers, and interested citizens contributed to this plan through completion of the questionnaire and review of the first draft. Recent reports of research needs analyses such as the "Ten Year Research Plan" (VIMS 1983), the "Six Challenges Facing the Chesapeake Bay" (Maryland Sea Grant In Press) and "Long-Range Research Needs for Chesapeake Bay Living Resources" (Houde 1987) provided additional information to make the plan truly comprehensive. The STAC Research Plan Development Committee thanks each of the individuals involved in these activities.

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INTRODUCTION

The Chesapeake Bay Program is the most ambitious estuarine management program ever attempted. The success of this attempt will depend upon a number of factors, not the least of which is a thorough understanding of the processes affecting the Bay and its living resources.

Our present understanding of the Chesapeake Bay and other estuaries is based upon several decades of research, much of which has been conducted by research institutions dedicated to the study of the Chesapeake Bay and its resources.

Our current understanding of the Bay must be tempered by the realization that estuaries are our most complex aquatic environment. Estuaries are neither continental freshwater systems nor oceanic marine systems but a complex mixture or hybrid of the two. Processes that can be clearly described or modeled in freshwater or marine systems may not function the same way in estuaries. Processes or properties that have temporal or spatial characteristics measured in years or hundreds of kilometers in the oceans can change over a few hours or a few meters in the estuary. Basic tenets of oceanography or limnology do not necessarily hold in the estuary.

The need for additional research on the Chesapeake Bay's problems, resources and processes is recognized by most participants in and supporters of the Bay restoration and protection efforts. Discussions and differences, however, frequently arise as to whether research efforts should be principally focused on very specific issues raised by management or on fundamental processes which would provide a broader understanding of a number of Bay problems.

Dr. Jerry Schubel has pointed out in a recent book[1] that estuarine science has suffered from sociopolitical pressures to restrict research in estuaries to "applied, relevant and responsive" programs, often without concern for the real scientific problems within the estuaries. The Chesapeake Bay has not escaped this constraint on scientific inquiry. The region is fortunate, however, that the principal research institutions have historically been closely affiliated with institutions of higher education. The research institutions' independence and charters have encouraged their scientists to retain a fundamental research perspective while pursuing management-oriented issues.

This approach to Bay research has lent continuity and insight to the efforts to preserve and restore the Bay. For example, as early as 1960 the Director of the Chesapeake Bay Institute put improperly treated sewage and municipal wastes at the top of a list of Bay problems. In the early 1970's the National Science Foundation Chesapeake Bay Study, after initiating studies on a broad range of problems, quickly focused its efforts on two areas, one of which was wastewater treatment and the impacts of eutrophication. This series of studies provided the basis for selecting nutrients as one of the major program areas of the five-year EPA Chesapeake Bay Study. The nutrient studies conducted by the EPA Chesapeake Bay Study provided the basis for focusing on nutrient controls in the Chesapeake Bay

Restoration and Protection Program. Does all this research mean that we know all there is to know in order to develop a definitive nutrient control strategy? No! Since the completion of the EPA study, new studies have shown the importance of nitrogen as a limiting nutrient in estuarine waters. It has become clear that nutrient control strategies must be firmly based on a good understanding of the temporal and spatial role of nitrogen in estuarine productivity.

Advances in understanding of estuarine function have primarily been developed on a disciplinary basis, with biologists working on biological problems, chemists working on chemical problems, etc. This approach has provided us with a good basic understanding of some of the processes at work in estuaries. We are fortunate in that much of what is learned in one estuarine system has some relevance in other estuarine systems. We have, however, determined that each estuarine system taken in its entirety has unique characteristics that must be understood if we are to manage that system.

To quote Dr. Schubel:

> Many of the important first-order disciplinary scientific questions on estuaries have been addressed; few of the second-order disciplinary questions have been considered; and almost none of the most important, complex interdisciplinary questions that relate to the interactions of the physical, chemical, biological and geological processes have been studied. It is this level of understanding which is required for effective management. The most important estuarine questions - at least for management - are fundamentally interdisciplinary in character.[2]

The second-order questions referred to by Dr. Schubel will require comprehensive, multi-year interdisciplinary basic studies of both the entire estuarine system and the subsystems that make up the Chesapeake Bay. The Restoration and Protection Program that has been launched on the Chesapeake Bay cannot, however, stay tied up at pierside waiting for all of the answers to all of the questions before setting sail.

To resolve this dilemma we have considered research planning in support of the Chesapeake Bay Program to consist of two parts: consideration of issues of immediate concern related to the specific objectives and commitments spelled out in the 1987 Agreement; and consideration of generic issues that require the study of the fundamental processes at work within the estuary. We firmly believe that it is necessary to address both specific and generic issues in developing an effective and comprehensive research plan in support of the Chesapeake Bay Restoration and Protection Program and more specifically the 1987 Chesapeake Bay Agreement.

The most important part of a comprehensive research plan for the Chesapeake Bay is a mechanism that encourages communication between the resource managers and the research community. This mechanism should enable the managers to review periodically (yearly at a minimum) their immediate short-term information needs with the principal managers of the Bay's scientific resources (i.e., laboratory directors, academic/research

department heads, major research program managers). The research community, for its part, should articulate clearly the newest understandings of estuarine and/or environmental processes and their potential relevance to Bay management activities.

Results of this communication should be:

Identification of priority research activities with short-term goals to provide immediate feedback to management efforts. A statement on these needs will provide the research community with guidance in research planning and a means of evaluating research results in terms of Chesapeake Bay management needs.

Identification of those fundamental processes which require attention in preparation for future management efforts. A statement on these needs will encourage the support of the management community for longer-term research that supports management activities in a generic sense.

This Plan proposes a mechanism to produce these results and to provide continuing assessment of research efforts and achievements.

[1] J.R. Schubel, 1986. Life and Death of the Chesapeake Bay. University of Maryland Sea Grant College. Publication (UM-SG-86-01).

[2] Life and Death of the Chesapeake Bay, op. cit.

RESEARCH PLAN

RESEARCH PLANNING COMMITTEE

We propose that the Research Plan Development Committee of the STAC be renamed to the "Research Planning Committee" and continued as a standing committee of the STAC and Implementation Committee (IC). This committee will be chaired by a member of STAC and will include at least:

-one STAC representative from each jurisdiction,

-one IC representative from a planning or management agency of each jurisdiction,

-one Citizens Advisory Committee (CAC) representative,

-one Local Government Advisory Committee (LGAC) representative, and

-three federal agency representatives (at least one from each of a research and development agency and a management agency).

ANNUAL RESEARCH ASSESSMENT AND PLANNING ACTIVITIES

To accomplish its task of ensuring the continued improvement of the scientific information base for use in Chesapeake Bay cleanup activities, the Research Planning Committee (RPC) will develop and annually update the following products:

1. a Chesapeake Bay research directory;

2. an assessment of the past year's Bay Program research achievements; and

3. a list of research priorities (short-term; generic, longer-term; and resources) and estimates of funding and resource requirements.

Overall guidance for the development of these products should be provided by STAC and the IC. Funding for staff support should be included within the annual STAC budget.

Chesapeake Bay Research Directory (CBRD)

The Research Plan Development Committee (herein the "Committee") believes that an important component of any research plan is the identification of existing research activities. In developing the initial draft of the comprehensive research plan, the Committee relied on the knowledge of its members, many of whom are heads of the Bay area research institutions. This "manual sort" of information and needs is sufficient for a first draft, but the Committee believes a formal inventory or directory of ongoing research projects should be established and maintained.

The Chesapeake Bay Research Directory would list:

1. current research projects and investigators,

2. funding level and sources,

3. summary funding information (i.e. total dollars, percentage for applied and basic research, trend information),

4. data access information, and

5. interim project products (progress reports, preliminary reports, etc.).

It is proposed that the following strategy and schedule for development of the CBRD be implemented:

a. Phase 1 - System design and compilation of data (begin 1 February 1989, complete 31 January 1990):
   - -define purpose and scope of directory
   - -review previous related activities and reports
   - -identify user audience and estimate potential use
   - -identify data sources (existing research listings, individual researchers, etc.)
   - -determine computer hardware and software needs
   - -select site for CBRD
   - -design CBRD system
   - -initiate data compilation

b. Phase 2 - Data entry (electronic and hard-copy); improvement, testing, and refinement of all software and hardware methods and equipment; development of maintenance strategy (complete by 31 January 1991):

   -specific details of activities to be defined during Phase 1

c. Phase 3 - Continued acquisition, entry, maintenance of system and liaison with users (ongoing):

   -specific details of activities to be defined during Phase 2

Benefits of a CBRD are clear to both managers and scientists. The managers will be able to rely on the directory as a resource for information on management questions. Scientists can use the directory as a supplement to the less formal research network to identify research activities complimentary to proposed work, or to identify potential voids or areas of research needs.

The Committee supports the development and maintenance of the CBRD and recommends that the IC support its development and operation for at least three years. After that time, its utility to both managers and scientists should be reviewed and evaluated for further funding.

Chesapeake Bay Program Research Achievements

The Committee believes that the public, managers, and scientists need periodic assessments of Chesapeake Bay research achievements if support is to continue at needed levels. Based on its review of the Chesapeake Bay Research Directory and independent reviews of research activities, the newly formed Research Planning Committee (RPC) will develop a brief progress report of the research efforts supported by the Bay Program. The report will be presented orally on an annual basis to the Executive Council. The Committee believes that this public accounting will reinforce public and financial support for both applied and basic research.

The Committee also recommends that the RPC assess on an annual basis recent advances in selected estuarine research both within and without the Chesapeake Bay which may have direct relevance to Bay restoration and protection efforts. This assessment should, in addition to reviewing the scientific or technical findings, point out the management implications of these findings.

Research Priorities

The Research Planning Committee will request each Chesapeake Bay component (task force, subcommittee, key agency, etc.) which perceives a need for research to review these research needs with the RPC on an annual basis. If the information to satisfy the research need as stated by the manager is already available, that information will be provided to the manager. If the RPC is aware of research underway that may satisfy the research need, it will also provide the managers with that information.

The RPC will then evaluate the remaining needs and where relevant combine these needs into a revised statement of prioritized short-term research needs. The RPC will also evaluate the underlying uncertainties generating the specific questions and modify the generic, longer-term research needs that should be addressed through fundamental, process oriented research.

The prioritized research statements, both program specific and process oriented, will be presented to the Implementation Committee for consideration as part of the annual budget process. At the same time, the RPC prioritization will be made available to the principal research institutions and research funding agencies active in Bay research.

The annual research priority list and the assessment of the past year's study results should be promulgated during July of each year to enable these statements to be used in the subsequent years' program planning.

Research Implementation Committee and Financial Resources

The Committee recommends that the IC establish a Research Implementation Committee (RIC) to address ways to support the priority research. The RIC should be chaired by an IC member and contain:

-representation from the IC,

-representation from state legislatures [Chesapeake Bay Commission (CBC)],

-representation from the Principal's Staff Committee,

-representation from STAC,

-representation from LGAC,

-representation from CAC, and

-representations from funding organizations.

The RIC should meet at least twice yearly to evaluate both the resources and needs based on existing known resources. A standing subcommittee, chaired by a member of CBC should be established to evaluate and recommend alternative options for funding new research. While the subcommittee is not limited in what it reviews, it could consider the feasibility of options such as:

-regional/state bond issues

-tax check offs

-legislation to dedicate environmental fines to research

The RIC should report its findings/recommendations to the IC annually.

Additional Information Exchange

To facilitate exchange of ideas, identification and evaluation of needs, and utilization of research results, a biannual Research Conference is proposed. In the interim, topical research meetings should be called to provide for the specific needs of the Chesapeake Bay Restoration Program.

1988 RESEARCH PRIORITIES

The Research Plan Development Committee's work during the past few months has provided the basis for an initial list of 1988 short-term and generic, longer-term research priorities which follows. It is expected that other priority items will be added during the next few months as key elements of the 1987 Bay Agreement are further developed. In particular, a toxics research plan is being developed by a STAC subcommittee in parallel with the toxics strategy. The 2020 Panel (the group of experts reviewing population growth and impacts) was established during the spring of 1988 and a research plan will be developed based on their deliberations. Both of these plans will be promulgated as addenda to this research plan.

SHORT-TERM RESEARCH PRIORITIES

The initial short-term research priorities were developed from the management oriented research needs in Appendix I:

1) **Sediment/water column nutrient flux studies.** These studies are needed to support development of the Time Variable model which will be a key element of the 1991 nutrient strategy review.

2) **Evaluation of BMP effectiveness.** These studies are needed to provide guidance for continued non-point source control strategies.

3) **Analysis of existing living resources data sets.** These studies are needed to provide information for immediate use in fishery and other living resource management programs.

4) **Initiation of appropriate data collection activities to provide data sets for use in stock assessment models.** These studies are needed to support fishery management and other living resource management efforts.

5) **Evaluation and analysis of monitoring data and techniques to enable development of cost efficient, cost effective monitoring to support proposed strategies.** Monitoring is necessary to track the success of the restoration program, yet can be expensive. The Bay monitoring program, therefore, should be subject to continuing review for relevance and efficiency.

6) **Determine physiological, cellular, subcellular, reproductive, and other sublethal responses to toxics to provide us with techniques suitable for supporting a toxics strategy when developed.** Most toxics management decisions are presently made on basis of lethability data yet there is potential of minute quantities of compounds impacting populations through chronic exposure. This complex problem must be examined further.

GENERIC, LONGER-TERM RESEARCH PRIORITIES

Research needs that are applicable to a wide spectrum of management concerns are described later in this plan. In contrast to the specific priorities listed above, these form the basis for longer term research activities. The priorities that emerge from these generic research needs are listed below.

1) **Develop a better understanding of the circulation and mixing processes in the Chesapeake Bay.**

2) **Develop better conceptual water quality models and conduct rigorous calibration and validation of these models.**

3) **Determine the interactions between various trophic levels (particularly pelagic) which appear to be implicated in the regulation of the abundance and structure of adjacent levels.**

4) **Develop a comprehensive understanding of the genetic makeup of living resources, particularly exploitable stocks in Chesapeake Bay.**

5) **Develop, calibrate, and validate conceptual models of the multitude of habitats that together make up the Chesapeake Bay ecosystem.**

6) **Develop an understanding of the significance of groundwater flow and groundwater contamination to Chesapeake Bay.**

7) **Develop an understanding of the impacts of specific land uses throughout the watershed on the aquatic and riparian habitats of Chesapeake Bay.**

RESEARCH SUPPORT PRIORITIES

To conduct the appropriate research it will be necessary to ensure that the research community within the Chesapeake Region is adequately prepared with resources. This will require investment in equipment, training, and facilities in both the near and intermediate term.

Some specific needs that have been identified as requiring particular attention are:

1) Advanced analytical chemical equipment particularly for identification of organic and metallo-organic complexes.

2) Development of remote sensing and automated technologies for providing synoptic, large area data and enumeration and identification of information presently only obtainable through tedious manual methods.

3) Establishment of a system of research reserves which will provide the research community with sites for long-term habitat focused research that will be protected insofar as possible from immediate threats from development.

Periodic assessment of resource needs such as these is essential due to the rapid advances in technology. This has been the case with analytical chemistry in the last decade.

GENERIC, LONGER TERM RESEARCH NEEDS

An effective Chesapeake Bay Research Plan must address both the short-term program specific information needs of the managers and the longer-term need to improve our understanding of the Chesapeake Bay system and its functional components. The allocation of resources between these two areas will undoubtedly be the source of a continuing dialogue between the management community and the research community. Yet, it is essential that both are included in a comprehensive research strategy.

The following statements of generic, longer-term research needs were developed by the Committee from an evaluation of the specific research needs statements as listed in Appendix I and their experience in dealing with Bay research and management issues. The needs may vary somewhat from year to year as we begin to develop answers to some of the questions posed but, in general, they will be relevant for a long period. Additions to this list can be expected as new areas of concern emerge or as simple management solutions are no longer viable.

UNDERSTANDING COASTAL HABITATS

Within the Chesapeake Bay system there are a number of diverse habitats ranging from tidal freshwater wetlands to oyster reefs to mesohaline and polyhaline marshes to beds of submerged aquatic vegetation. In addition to these specific coastal habitats, the entire water column must be considered as a habitat for planktonic and pelagic species. These habitats possess unique biological, physical, and chemical characteristics which interact to make the habitat what it is. The interactions between and among habitats combine to provide the complex ecosystem of the Bay and tributaries.

Although much of our focus of Bay resource management is on individual species of concern or the various materials entering the system, the ultimate focus of management should be maintenance of healthy habitats. At this time, however, it is not possible to manage for a healthy vigorous habitat because we do not know what combination of biological, chemical, or physical factors are required for a healthy habitat. Nor is it possible to evaluate the condition of a given habitat because we have no criteria for determining whether a habitat is in a healthy, declining, or improving condition. (It is sometimes apparent when a habitat has collapsed, i.e. grasses are gone, benthic populations are buried, etc.).

Bay resource managers are frequently faced with this dilemma as they must evaluate the potential impact of diverse demands to modify habitats. The scope of these demands may range from an individual homeowner desiring to install a short length of bulkhead in front of a vacation cottage to a municipality desiring to build a many thousand acre reservoir to provide freshwater to meet demands of residential or industrial growth.

Research Needs

To improve our understanding of these issues, a number of research areas must be pursued.

A) Submerged aquatic vegetation (SAV) habitats.

As a result of Chesapeake Bay Program studies, some progress has been made in our understanding of the requirements for and the recent fluctuations of SAV habitats in the Bay The importance of SAV habitats, particularly Zostera marina (eel grass), as nursery areas refuges for juveniles is beginning to be quantified. This work should be continued and expanded to other species of SAV's. Specific attention should be focused on quantifying the importance of SAV habitats in recruitment of commercially important species such as blue crabs and various finfish. The value of SAV habitats in comparison to other shallow water habitats should be assessed.

B) Emergent saline tidal marsh habitats.

An extensive literature exists on the ecology of coastal saline tidal marshes. We have a qualitative and semiquantitative understanding of the role of these habitats in the Bay. It is generally accepted that the tidal marshes must be maintained in order to maintain a viable Bay. Increasing shoreline use threatens emergent wetlands. To accommodate legitimate shoreline use while maintaining the present wetland habitats, mitigation measures involving construction of new wetlands are often utilized.

Our knowledge of wetlands ecology particularly internal structure and functional relations does not allow us to fully evaluate the equivalency of natural marsh systems to manmade marsh systems. Comparative studies of natural systems and manmade will provide the information needed to fully evaluate mitigation measures.

C) Tidal freshwater habitats.

The upper reaches of the Bay and major tributaries, beyond the limit of salt intrusion, but still under the influence of tides are poorly known as biological systems. What is known is that these are important spawning areas for anadromous species and nursery areas for species spawned offshore. These regions are marked by seasonally emergent wetlands, the function of which in the utilization, storage and release of nutrients is poorly understood. Population growth and developmental patterns in the Bay watershed have until recently left these areas relatively undisturbed. Recent population increases and new development patterns have begun to threaten these habitats both directly and as a potential source for freshwater supplies. We must develop conceptual and functional models of these systems to enable us to meet the threats to their viability.

D) Non-vegetated wetlands.

Intertidal and shoal benthic non-vegetated substrates constitute a significant estuarine habitat in the Chesapeake Bay. Compared to other habitats, the resource value and functional ecology of these habitats is almost unknown. Recent studies have indicated that production (micro-autotrophic) and metabolism (respiration) in these areas are relatively high and may be comparable to better studied habitats such as SAV's and tidal marshes. The resource value of these habitats should be quantified.

E) Benthic habitats.

The presence of organisms in and on the bottom are reflective of the type of substrate. These organisms are also modifiers of the physical structure and stability of the bottom sediments. Benthic organisms through their living activities can greatly influence or control the movement of chemicals (both toxic and non-toxic) between the overlying water column and the sediments. The fundamental significance of benthic populations, however, pertains to energy flow in that, like the plankton, they serve as a major link in the food web of the Bay, passing energy from primary producers to top carnivores (fish and crabs). The functional importance of these habitats and the resource value of different benthic regions are major unknowns in our understanding of the estuary.

F) Oyster reefs.

Oyster reefs are (or once were) dominant habitats within the Chesapeake Bay and its tributaries. Many reefs have been greatly modified by over a century of active oyster harvest. Attempts to revitalize oyster reefs by shell planting, transplanting of seed and other means are frequently not successful. Proposals for using artificial substrates periodically emerge (tire chips are the most recent candidate for reef revitalization). The functional relationships between water quality, circulation, substrate, and reef relief are poorly understood. This lack of understanding is a major impediment to rehabilitation efforts.

G) Coastal and Contiguous Habitat Modification.

Habitat modifications include both small disturbances to the natural system which, by themselves, appear to be relatively innocuous but which in the aggregate may have significant impact, and larger projects which, by themselves, could generate significant impacts (e.g. extensive shore stabilization structures; dredging and dredge material disposal; interbasin freshwater transfers; impoundments for water supply, water power, or waterfowl management).

Managers and regulators must evaluate the potential benefits as contrasted to losses of these modifications and attempt to minimize

adverse impacts. Where applicable, this may require mitigation of the losses by requiring improvements to habitats elsewhere.

Each proposed modification will, of course, require a site specific evaluation of impacts, but there are a number of boarder questions that require answers. Are compensation and mitigation techniques effective? What are appropriate ratios for creating habitat to mitigate loss of established habitat? For example how much new habitat should be created to mitigate for loss of a mature, 50 year old wooded swamp. Are artificial habitats such as reefs an effective integration tool? Is dispersal of activities such as marinas a useful approach? Or, is it better to concentrate impact in a few selected areas?

Estuarine Research Reserves

The states of Maryland and Virginia have initiated the establishment of a series of estuarine research reserves in cooperation with the National Estuarine Research Reserve Program of NOAA.

A comprehensive research reserve system would provide a protected site within each of the functional segments of the Bay and its major tributaries. Here long-term studies could be conducted to begin to define the functional relationships of the various Bay habitats and to provide a basis for determining the status of the habitats in relation to development within the tributary watershed.

As has been previously stated, it is not possible at this time to determine whether a habitat is healthy, declining or improving. The Bay estuarine research reserve system when complete will at least provide us with a series of protected sites within which a long-term habitat monitoring program can be initiated. In the absence of established criteria and indicator processes for determining habitat "health," the initial thrust of a long-term habitat monitoring program will of necessity focus on research on functional relationships.

UNDERSTANDING WATER COLUMN PROCESSES

The statement has been made that Chesapeake Bay is to a great extent a plankton based system. The bulk of the primary production in Chesapeake Bay is derived from phytoplankton photosynthesis and it is this production which supports the high productivity of the Bay in terms of fish and shellfish.

Much of the primary production is consumed and cycled within the plankton community itself. Since the plankton community constitutes both the base of the production in the Bay and a substantial part of the aquatic food web, many of the ecological processes in the estuary are directly related to the chemical, biological and physical processes interacting within the water column.

The most immediate expression of water quality changes within the Chesapeake Bay and its tributaries is found in the water column.

Phytoplankton blooms, hypoxia/anoxia, increased turbidity, all result from excess material additions (particularly nutrients) to the water column.

Research Needs

In order to understand the functional processes occurring within the water column a number of studies must be continued.

A) Understand the biological, chemical and physical processes related to the plankton community, particularly those which relate to inorganic nutrient recycling, replenishment and storage (within organisms and the bottom sediments). The importance of micro-circulation processes (spring-neap overturns, upwelling, wind induced mixing) and the cycling of nutrients between the water column and the bottom sediments must be understood in order to fully evaluate future pollution control strategies.

B) Understand the interactions among the mainstem, major tributary, adjacent shelf, and smaller tributary water bodies and associated communities. These adjacent water bodies (coastal shelf waters, marsh creek waters, Eastern Shore embayments, smaller western shore tributaries) exchange organisms, nutrients and pollutants with the Bay system water bodies. These smaller water bodies are also those which first receive the impact of man's activities and serve as conduits, storage areas and modifiers of many of the additions to the system generated by these activities.

C) Develop or acquire improved technology and methodologies for studies of water column processes, particularly those impacting the smaller phytoplankton (bacteria, microflagellates, etc.) which are estimated to contribute the major portion of the primary production, yet are among the least studied and understood portions of the phytoplankton community. Traditional microscopic approaches to identification and enumeration have reached the limit of their capability to assist us in understanding these systems. A concerted effort to develop automated identification and enumeration systems, automated sampling systems, high resolution identification systems and the conceptual models for evaluating the output of these new systems must be made.

UNDERSTANDING THE PROBLEM OF TOXICS IN THE CHESAPEAKE BAY SYSTEM

[NOTE--The 1987 Bay Agreement calls for the development of a toxics strategy by December 1988. A toxics workgroup of the STAC is preparing a toxics research plan to be considered as part of this toxics strategy.]

A toxics component of the research plan is currently being developed in parallel with the toxics strategy and will not be presented at this time. It is already apparent, however, that the research community must address the critical issue of sublethal and other effects of toxics compounds. The problem of determining the impacts or effects of toxic compounds short of

killing the organisms is one of the key problems facing investigators dealing with toxics.

Many chemicals are in themselves not toxic, but when assimilated into specific organisms are modified into toxic entities. On the other hand, some toxic compounds are detoxified by enzymatic systems of other organisms. The question of physiological modification of toxics and the determination of the adverse sublethal physiological effects of toxics is one which must be addressed before an accurate assessment of the toxics problem can be made. Such questions as toxic impacts on immune systems, reproductive systems, growth and development, maturation, etc. must be addressed. The ability to address these questions will depend upon the ability of investigators to access state of the art instrumentation and methodology in the fields of analytical chemistry and cell biology. The Chesapeake Bay research community must ensure that such capabilities exist in the region.

UNDERSTANDING THE CIRCULATION OF WATER IN CHESAPEAKE BAY

A thorough understanding of circulation (movement of water) is a necessary factor in our understanding of the distribution of living resources, the movement (disposal, concentration, or transport) of toxics and the movement of nutrients. Conceptual models of estuarine circulation, particularly in the Chesapeake have been dominated by the elegant framework of a two layered salinity density structure arising from freshwater discharge overriding and entraining underlying saline water. This structure results from a net seaward flow in the surface layer and a net landward flow in the bottom layer, as postulated and validated by Pritchard in the 1950's.

We have come to realize that our present knowledge of the physical processes that control mixing and circulation in Chesapeake Bay is incomplete. Forces affecting circulation (tides, winds, solar heating, freshwater discharge, ocean coupling) have been identified, but their real time effects are known only in a qualitative sense. It is only in recent years that the importance of short-term processes (time scale of a tidal period to a month, i.e. tidal variations, long-period internal waves, cross-bay seiching) and short period, small scale mixing processes (time scale less than a tidal period, i.e. short period internal waves, turbulent and boundary layer mixing) have been recognized.

The importance of a full understanding of circulation in a real time sense is underscored by the development of advanced models for use in management decisions. These are being developed to work in a three dimensional, time variable mode as opposed to the traditional two dimensional (or quasi three dimensional) steady state models.

Research Needs

In order to improve our understanding of Chesapeake Bay circulation a number of studies should be conducted.

A) Long-term measurements with modern remote sensing and profiling instruments are needed. A number of new techniques such as radar backscatter from shore stations, bottom mounted acoustic profiling current meters, and satellite remote sensing should be used in combination with each other to quantify the physical processes over a wide range of time scales.

B) The function, importance and continuity of surface features such as eddies, fronts and plumes should be examined both spatially and temporally in context of their possible function in living resource, nutrient and toxic transport.

C) Specific processes (anoxia, transport of planktonic larvae) should be examined through field studies designed to capture initiation or formation, maintenance and breakdown and other physically determinate factors.

D) The role of wind induced mixing on productivity, concentration and dispersal of toxics and recruitment and distribution of living resources, should be studied. Particular emphasis should be placed on the disruption or interruption of wind induced mixing on physical processes driven by more predictable factors.

UNDERSTANDING THE GENETIC VARIABILITY OF CHESAPEAKE BAY STOCKS

Although the focus of management efforts in the Chesapeake Bay Program is on the reduction of excessive introduction of various materials (nutrients, toxics, sediments, etc.) into the waters of Chesapeake Bay, the reason for this activity is to improve the water quality and habitat quality to the point that living resources (particularly exploitable species) are restored to some higher level than presently found within the Bay.

As management efforts to improve water and habitat quality begin to have an affect, living resource intervention strategies must be developed to exploit the improved conditions. Several intervention strategies ranging from doing nothing and letting nature take its own course to control of harvesting, creation of enhanced habitats, supplementing natural recruitment with hatchery reared and released individuals to full replacement of natural populations with domesticated populations, are possible.

In order to help choose between these strategies and to ensure that the selected strategy or combination of strategies is successful, an understanding of the genetic structure of the species of concern is necessary. A living resource manager must know whether the species of concern are genetically similar throughout its range or whether there are

many highly differentiated subpopulations which might imply genetic adaptation to highly localized conditions.

Research Needs

Research on the genetics of Chesapeake Bay populations needs to be conducted on a number of fronts.

A) Present efforts to define the genetic variability and structure of Chesapeake Bay stocks should be continued until the natural genetic structure is clearly defined for all species of concern.

B) Genetic selection or genetic engineering should be attempted for those species which face a specific impediment to their restoration, rehabilitation, or survival (e.g. MSX or Perkinsus resistant oysters).

UNDERSTANDING WATERSHED PROCESSES

The watershed that funnels billions of gallons of water a day into Chesapeake Bay represents over 90% of the land area of the Basin. This water accumulates into less than 10% of the basin area - Chesapeake Bay. Land based activities in the entire watershed have a direct effect on the stream and river water delivered to the bay. Streams and rivers collect not only water from precipitation runoff and groundwater flow, but also dissolved and suspended particle material from the watershed. The goal of a restored Chesapeake Bay will be achieved only with great attention applied to managing watershed activities. Appropriate strategies based on a solid understanding of watershed dynamics should yield significant results.

Within the watershed are a variety of geological provinces and land use patterns. Each has a specific effect on stream water quality that usually is transported to the bay. Urban areas that are situated on the major rivers contribute a variety of metals and organics from non-point runoff, combined storm sewer overflow, and groundwater intrusions. The vast expanses of agricultural lands from which chemicals and sediment flow into the streams, introduce changes in water quality and biology. There are substantial shifts in land use such as reversion to forested lands or development into housing subdivisions that affect the quality and quantity of water flowing to the Chesapeake. It is important to assess the impact of these land use changes on the restoration effort since this pattern of change is expected to continue. Degraded water quality in many estuaries and large rivers is often associated with poorly controlled land based activities in the watershed.

Research Needs

There are several information needs to be addressed to improve our understanding of the role of watershed dynamics in stream and river water quality.

A) The transport of dissolved and suspended (particulate) material within the watershed and the ultimate fate of this material in the associated water channel.

B) The processing of dissolved and particulate material within the watershed by geochemical, microbial, and other biological activity.

C) The effects of various land use activities on water runoff and groundwater recharge on water quality.

D) The role and extent of water transport and transformation (such as nutrient cycling) within the stream channel and riparian zones extending to the fall line.

E) The roles of different land use patterns in controlling or modifying the effect of seasonal discharge patterns in the different tributaries.

F) The roles of different riparian zones in modifying the effect of fluctuation in discharge.

G) Development of an accurate baywide land use map with a classification system to specifically identify various agricultural practices (i.e. no-till versus conventional till) and coastal habitats (i.e. coastal dunes, swamp forest, tidal freshwater marshes).

UNDERSTANDING THE CONTRIBUTION OF GROUNDWATER TO THE BAY

Groundwater movements are logically an integral part of the circulation patterns of the Chesapeake Bay. It is probable that groundwater adds flow to the Bay in some areas while it abstracts flow at other sites. It is also likely that the extent of the inputs and outputs varies seasonally with magnitude of precipitation.

The groundwater inputs become sources of both nutrients and toxicants, but the significance of these inputs is currently unknown. In addition, the inflowing groundwater must pass through the sediments deposited in the specific area of inflow, and this will affect the chemical nature of those sediments and the quantity of chemicals (nutrients, organics, and toxicants) released from the sediments to the water column in that area. The way the inflowing groundwater affects sediment chemical release will depend to some extent on the past history of the groundwater, i.e. does it contain dissolved oxygen and what is its pH? On the other hand, outflowing groundwater should actually reduce the release of pollutants from the sediments to the water column and result in a reduction of soluble chemicals

in the Bay. At present, the magnitude of these events, and the areas affected, are virtually unknown.

Many of the best management practices being considered for implementation retard or prevent surface runoff (with associated loads of dissolved and particulate material) from entering the Bay or tributaries. If this dissolved or particulate material does not enter the Bay, what happens to it? Is it metabolized or degraded through microbial or geochemical action or does it merely get diverted to the groundwater? Diversion of pollutants to the groundwater may not solve the Bay's problems, it may just postpone them or create worse problems in other areas.

Research Needs

Considering the potential importance of the groundwater movements and the need to accurately account for all sources of pollutant inputs when formulating appropriate control strategies, studies are needed to improve our understanding of groundwater movements and impacts. The following studies are recommended:

A) Identification of areas of groundwater inputs and outflows within the Chesapeake Bay, and seasonal changes in the areas affected.

B) Long-term measurements of the net groundwater inputs to the Bay, and seasonal variations.

C) Quantification of the chemical characteristics and pollutant loads of the groundwater inputs and outflows, and seasonal variations.

D) Investigation of the impacts of groundwater inputs and outflows on sediment-water column pollutant interactions, and seasonal variations.

E) Investigation of methods that will potentially reduce groundwater pollutant transport into the Bay and evaluation of BMP effects on groundwater contamination.

F) Specific efforts are needed to comprehensively assess the current extent and magnitude of groundwater contamination by pesticides and mobile nutrient species (i.e. nitrates). The following goal oriented investigations are recommended for implementation in both the short and long-term.

    1) Extensive measurement of pesticide and nitrate contamination of groundwater in the Chesapeake Bay vicinity to enable accurate quantification of the transport of these pollutants into the Bay via groundwater flows.

    2) Investigation of pesticide transport processes via groundwater.

    3) Development of BMP's to reduce groundwater pesticide and nitrate contamination.

4) Development of alternative pest management practices consistent with the goals of the Chesapeake Bay restoration effort.

5) Development of new technologies for pesticide analysis and decontamination.

6) Development of new technologies for nitrate decontamination of groundwater.

UNDERSTANDING THE SOCIO-LEGAL-ECONOMIC IMPLICATIONS OF ALTERNATIVE MANAGEMENT APPROACHES

Determining the most effective policies to restore and preserve the Bay demands continual coordination of research with resource management, environmental monitoring, public education, and technology transfer. By far, the majority of decisions related to restoration and preservation of Chesapeake Bay will be social or political decisions. Science and technology will provide a number of technological fixes that would enable us to resolve a given problem. Each "fix", however, will involve different social, legal, economic, political and environmental tradeoffs.

The full extent of these tradeoffs must eventually be understood if the widespread social and political support for a clean Chesapeake Bay is to be maintained.

The studies of natural scientists and engineers, therefore, must be supplemented by and coordinated with research by political scientists, legal scholars, social scientists, and economists. This will ensure we consider not only the natural and physical sciences, but also the political implications of policy planning, cultural traditions, and social values that influence decision making.

Research Needs

The suite of research needs in the socio-legal-economic area has not been as clearly defined as in the natural sciences because there is neither the number of scholars in this area focusing on Chesapeake Bay problems or as extensive a history of socio-legal-economic studies as in the natural sciences. The attention paid to this area in the near term should be increased. Some research areas that have been identified are:

A) Identify and, where possible, quantify demographic, social, and economic trends within the Chesapeake watershed.

B) Define the ways in which science and policy should interact in the context of social values, cultural heritage, and political expediency.

C) Evaluate the effectiveness of alternative methods of environmental protection or management using economic criteria such as tax incentives (e.g. tax credit or pollution taxes, licenses , etc.).

D) Evaluate effectiveness of alternative methods of environmental protection or management using behavioral criteria (moral persuasion, volunteerism, etc.).

E) Evaluate effectiveness of alternative statutory or regulatory approaches to environmental protection or management in Chesapeake Bay.

OTHER AREAS OF POTENTIAL RESEARCH NEEDS

A number of other research areas were discussed during the preparation of this plan. Two of these areas, Toxics and Population Growth and Development, are being addressed by other components of the Bay Program, and addenda to this plan can be expected in the near future.

Additional research areas were identified as needing attention. Two of these, Public Health and the Chesapeake Bay Ecosystem and Non-Tidal Wetlands, are of particular concern, and the Committee agreed that the next plan iteration should establish research needs statements in these areas.

CONCLUSION

Proper management of Chesapeake Bay requires a very broad information base encompassing many kinds of information. The Chesapeake region is fortunate that past research activities have provided us with a substantial information base that has brought us to our present level of understanding of the Bay's resources, processes, and problems. The Chesapeake Bay Research Plan can be viewed as the blueprint or roadmap to provide for the continuing improvement in the information base in an effective and timely fashion.

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APPENDIX I

Analysis of Research Needs Associated With Specific Objectives and Commitments of the 1987 Chesapeake Bay Agreement

Research Plan Questionnaires and coded Chesapeake Bay Agreements were distributed Bay-wide to scientists and resource managers. Of the 350 distributed questionnaires, 28 percent were completed and returned. Information and research need responses from the questionnaire were compiled according to Chesapeake Bay Agreement identified category (i.e. Living Resources, Water Quality etc.) objectives and commitments.

The compiled information and research needs were distributed to the STAC Research Plan Committee. The Committee divided into workgroups according to Chesapeake Bay Agreement categories. Within each workgroup the following procedure was followed for each objective and commitment:

- inapplicable information and/or research needs were deleted or transferred;

- closely related information and research needs were grouped, and, if necessary, reworded;

- for each information need, it was ascertained whether a research need had been identified to fulfill it and, if not, an appropriate research need was written;

- closely-related research needs were grouped and, if necessary, reworded.

These research needs, along with the coded Chesapeake Bay Agreement objectives and commitments which they aid in fulfilling, were compiled for review.

The results for this work are presented below. The CBA Code refers to the Chesapeake Bay Agreement category (LR-Living Resources; WQ-Water Quality; PG-Population Growth and Development; G-Governance; PA-Public Access; PI-Public Information, Education and Participation) and the specific objective or commitment ("...O..." for objective and "...C..." for commitment). A coded copy of the Chesapeake Bay Agreement of 1987 is attached.

LIVING RESOURCES

GOAL: Provide for the restoration and protection of the living resources, their habitats, and ecological relationships.

1) COASTAL HABITATS

CBA Code	Research Needs
LRO-01,02 LRC-02 GC-02	Evaluate and assess the relative contribution of uplands, riparian vegetation, wetlands, and submerged aquatic vegetation to energy flow within the Bay system.
LRC-01	Determine the importance and functional roles of various coastal habitats, vegetated and unvegetated, on the ontogeny of commercially and ecologically important species.
LRO-01	Determine water quality requirements for growth and survival of submerged aquatic vegetation in various parts of the Bay; this should be attempted with the data base using GIS.
LRO-01	Determine the role of sedimentation in changing the suitability of substrate for submerged aquatic vegetation and the role of toxic chemicals in hindering growth and reproduction of submerged aquatic vegetation.
LRO-01,02 LRC-05 PGC-03,04 GO-08 GC-02	Update Chesapeake Bay Watershed submerged aquatic vegetation and wetland inventories; inventories should include non-tidal wetlands and assess the relative "quality" of existing submerged aquatic vegetation and wetlands.
LRO-01,02 LRC-05 WQO-06 PGC-02,03 04 GO-06 GC-02	Monitor existing and future submerged aquatic vegetation and wetland creation projects and evaluate habitat creation as a management tool; this includes development of economic, logistic, and success criteria, and comparison of ecological values of created and natural submerged aquatic vegetation and wetland systems.
WQO-03,11 WQC-01 PGO-06 PGC-04 GC-02	Determine the importance of wetlands to pollutant assimilation and determine how function and assimilative capacity are altered by point sources discharges into such systems.

LRO-02 LRC-01,05 PGC-04 GC-02	Determine the ecological value of fringe wetlands versus larger extensive wetlands and evaluate the level of management effort currently devoted to such wetlands.
LRO-02 LRC-01,05 PGC-04 GC-02	Determine the community structure and dynamics of the tidal-nontidal wetland interface and evaluate the role and value of nontidal wetlands and their relation to the Chesapeake Bay system.
LRO-02,05 GC-02	Determine the response and rates of change of Chesapeake Bay wetland systems to natural (i.e. sea-level rise) and man-induced (i.e. river impoundments) phenomena.
LRO-02,03 LRC-01 GC-02	Develop the methodology to design a combined profile for dune, beach, bar, and underwater mound in order to stabilize and protect shorelines from north-east and hurricane strength storms at specific recurrence intervals.

2) TROPHIC DYNAMICS

CBA Code	Research Needs
LRC-01 GC-02	Determine essential components of the planktonic and microbial food webs, rates of energy flow among these components, and the ecological controls over the composition and function of these food webs.
WQC-01 GC-02	Examine the role of nutrient recycling in supporting primary production, considering how changes in nutrient ratios (N:Si:P) affect the phytoplankton community profiles.
LRC-04 GC-02	Identify and evaluate predator-prey relationships for ecologically and commercially important species.
LRO-04 LRC-01 GC-02	Determine the relationship of freshwater inflow with impacts upon habitat and trophic structure of living resources of the Chesapeake Bay system.

3) LIVING RESOURCES PROTECTION, ASSESSMENT AND MANAGEMENT

CBA Code	Research Needs
LRO-05,06 07 LRC-03,04	Develop yield modeling as a tool for fishery management decisions; both single-species and multiple-species population modeling should be undertaken for harvestable living resources.
LRO-05,06 07 LRC-01,02 04 GC-05	Develop and test of sampling methodology and recruitment, disease, mortality, and abundance indices in order to provide a more accurate, comprehensive and standardized assessment of Bay-wide finfish and shellfish stocks.
LRO-06,07 LRC-02,03 04 GC-05	Develop better recreational and commercial fishery statistics in order to determine their impact upon fishery stocks.
LRO-06,07 LRC-02,03 04	Evaluate socio-economic aspects of fisheries management within the Chesapeake Bay and its tributaries.
LRO-05,07 LRC-01,02 GC-05	Develop cellular level assays (macrophage function, enzymatic inhibition) in order to assess the degree of exposure to environmental stress and monitor the general health of a fish stock.
LRO-05,07 LRC-01,02	Examine the relationship between finfish/shellfish and parasites and pathogens, including the role of environmental conditions in affecting susceptibility of finfish/shellfish to diseases.
LRO-05,07 LRC-01,02	Studies of finfish/shellfish relationship between survival of all life stages (with emphaisis on early life stages) and natural and anthropogenic factors, such as siltation, hypoxic/anoxic conditions, toxic chemicals, salinity, and food availabilty.
LRO-07 LRC-04 GC-02	Evaluate the suitability of benthic sediments on the recruitment of planktonic larvae of benthic organisms.
LRO-06,07 LRC-03,04	Assess the benefits and risks of developing and releasing biota that may supplement or replace natural finfish or shellfish populations.

LRO-05,06 07 LRC-02 GC-05	Identify physiological and genetic differences among key Bay finfish and shellfish stocks; this information should be developed for use in fishery management plans in order to identify stocks and maximize production and restocking efforts.
LRO-06 LRC-04,06 PGC-02	Inventory dams and other impediments Bay-wide for migratory fish passage, and identify those impediments no longer in use that could be breached.
LRO-06 LRC-04,06 PGC-02	Assess the effectiveness of present fish passageways and develop more effective designs for finfish passage.
LRO-01,06 LRC-04,06 PGC-02	Determine the effect of low freshwater flow on the migratory behavior of anadromous finfish, and establish minimum in-stream flow requirements for these finfish.
LRO-01,02 04,06 07,08 LRC-01,04 05,06 PGC-02	Explore the relationship between freshwater inflow and the trophic structure of living resources of the Bay system.
LRO-01,02 04,08 LRC-01	Determine and evaluate the effect of shoreline development, and of various land-use practices, on the survival and recruitment of waterfowl and wildlife on the Bay and its watershed.
LRO-08 LRC-01 WQC-02	Determine the effects of toxic chemicals on waterfowl and wildlife populations of the Bay.

WATER QUALITY

GOAL: Reduce and control point and non-point sources of pollution to attain the water quality condition necessary to support the living resources of the Bay.

1) ASSESS NUTRIENT, TOXIC MATERIAL AND SEDIMENT CONTROL STRATEGIES:

CBA Code	Research Needs
WQO-03 WQC-01 PGO-02,06 PGC-02	Evaluate the effectiveness and capabilities of new and alternative waste water treatment systems that improve nutrient control by performing comprehensive, long-term demonstrations (i.e., biological nutrient removal, land application of effluent).
WQO-08 WQC-02 PGO-02 PGC-02	Evaluate the effectiveness and capabilities of the Industrial Pre-treatment Program on reduction of metals and other contaminants in sewage and sludge.
WQO-05,13 WQC-01,03 PGO-02 PGC-02 LRO-03	Evaluate and quantify the effectiveness of existing management practices (including riparian vegetation, buffer strips, buffer fringe and extensive wetlands, slit-till, no-till, etc.) on reducing the movement of nutrients, agricultural chemicals, sediments and other contaminants to the Bay and its tributaries through groundwater, surface water, sediment, and atmospheric transport, and develop management practices that maximize reduction efficiency from a variety of land-use types.
WQC-01,03 PGO-02 PGC-02 LRO-03	Evaluate the effectiveness of shoreline erosion control strategies (i.e., gapped and headland breakwaters) under various shoreline conditions, and identify areas of high erosion where such strategies should be implemented.
WQO-05 WQC-01,03 PGO-02 PGC-02 LRO-03	Identify, classify and prioritize, by means of available monitoring, research, and/or modeling; the watersheds and Bay areas where proven sediment and nutrient control strategies for point and non-point sources should be applied.

2) ASSESS DISCHARGE STANDARDS AND WATER QUALITY PROTECTION/ENFORCEMENT:

CBA Code	Research Needs
WQO-04 WQC-02 LRC-01	Develop water quality standards for pollutants that enter the Chesapeake Bay and its tributaries; determination and prioritization of major pollutants for control should be accomplished by acute and chronic toxicity tests on Chesapeake Bay and tributary biota.
WQO-04	Determine the resources and personnel necessary to enforce compliance with water quality standards and legislation.
WQO-10	Test various emergency response methods and procedures for minimizing water pollution from hydrocarbon and other pollutant spills, and identify the most effective responses under various conditions.
WQO-12	Identify legal considerations and constraints pertinent to the protection and development of the Chesapeake Bay watershed groundwater resources.
WQO-11	Develop of long-term assessment from maintenance dredging of harbors and slip channels of toxics, heavy metals, nutrients, and other contaminants returned to the water column, and determine if detrimental effects are localized or widespread.

3) ASSESS NUTRIENT AND TOXIC MATERIAL BUDGETS:

CBA Code	Research Needs
WQO-05 WQC-01 PGC-02	Determine with greater accuracy the land-use patterns within the Chesapeake Bay watershed, especially in regard to agricultural classifications (i.e., no-till, conventional practice), to be used in the Watershed Basin Model; a GIS format is suggested.
WQO-05 WQC-01 PGC-02	Develop on-field nutrient budgets for P and N (accounting for plant uptake, volatilization, soil storage, surface and subsurface flow) for a variety of soils, crops, and tillage practices.
WQO-05,08 WQC-01,02 03,04 PGO-05 PGC-02,03	Examine large-scale industrial operations (logging, mining, shipyards, etc.) and urban land-use practices affect the inputs of nutrients, toxics, and sediments to the Bay and its tributaries.
WQO-08 WQC-02 PGC-02	Identify sources of toxic material discharges within the Chesapeake Bay and its tributaries.
WQO-05,08 12 WQC-01,02 04 PGC-02	Determine, qualitatively and quantitatively, the direct contribution of nutrients and other contaminants from shallow aquifers to the Chesapeake Bay and its tributaries under a variety of land-use patterns.
WQO-05,08 12 WQC-01,02 PGC-02	Identify the magnitude and mechanisms of transport of nutrients (natural and man-made) and agricultural chemicals to groundwater under various application and tillage practices and soil types.
WQO-05,08 13 WQC-01,02 PGC-02	Identify and quantify wet and dry atmospheric pollutant contributions to the Bay and its tributaries.
WQO-05,13 WQC-02 PGC-02 LRC-01	Identify toxic contaminants found within the water surface microlayer, and determine their sources, and their impacts upon Chesapeake Bay living resources.

WQO-05,08	Determine the role and the spatial and temporal variability of infauna in mediating the flux of nutrients and toxics across the sediment- water interface.
WQO-05,08 WQC-01,03 PGC-02	Determine the quantitative importance of sediment and sediment processes in the fate and flux of toxics and nutrients within the Bay and its tributaries.
WQO-05 WQC-01,02	Determine the nature and the spatial and temporal variations of redox processes in the water column and the effect of sedimentary nutrient regeneration on water column nutrient distributions.

3) TROPHIC RESPONSES

CBA Code	Research Needs
WQC-01 LRC-01 GC-02	Determine and evaluate the quantitative links between nutrient loadings and response of primary productivity and trophic relationships.
WQO-08 WQC-02 LRC-01 GC-02	Identify components, mechanisms, pathways and acute/chronic effects of sediment-associated toxics on Chesapeake Bay biota.

4) PHYSICAL PROCESSES

CBA Code	Research Needs
WQC-01,02 03 LRO-04 LRC-01 GC-02	Determine the Bay-wide circulation dynamics and stratification under a variety of freshwater inflow conditions.
WQC-01,02 LRC-01 GC-02	Determine and evaluate the temporal and spatial variability of Bay and tributary low oxygen water and the physical and biological processes regulating it.
WQC-01,02 03 LRC-01 GC-02	Determine in greater detail the wind stress fields and the effect of their variation on circulation and mixing patterns in the Chesapeake Bay and its tributaries..
WQC-01,02 03 LRC-01 GC-02	Evaluate and assess with greater spatial resolution the short-term, high-frequency transport and mixing processes within the Chesapeake Bay system.
WQO-11 WQC-01,02 03 LRC-01 GC-02	Evaluate and assess hydrodynamic mechanisms for sediment resuspension, dispersal, and redeposition in the benthic boundary layer.
WQC-01,02 03 LRC-01 GC-02	Quantify the exchange of materials among the Chesapeake Bay, its major tributaries, and the ocean, and calculate residence times for materials in the Chesapeake Bay system.

POPULATION GROWTH AND DEVELOPMENT

Goal: Plan for and manage the adverse environmental effects of human population growth and land development in the Chesapeake Bay watershed.

CBA Code	Research Needs
PGO-02,03 PGC-02,04 LRO-01,02 03,04 LRC-01,05 WQC-01	Develop criteria for local government to utilize in local land use management and planning for comprehensive land use and preservation and enhancement of Bay and tributary water quality.
PGO-02,03 PGC-04 PAO-04 LRO-01,02 03,04 LRC-01,05 WQC-01	Develop criteria to identify sensitive areas and to govern the quality of development within these areas; these criteria should be designed for easy incorporation into local ordinances and enforced by local governments.
PGO-02,03 LRC-01 WQO-04	Develop criteria for determining ecological carrying capacity of coastal lands and waterways (e.g. marinas, oystering, residential development, vessel traffic).
PGO-02,06 WQO-01,03 11	Identify feasible waste management alternatives for implementation by municipalities with emphasis on source reduction and recyling/reuse.
PGO-02	Examine demographics and economic development on land use as it impacts Chesapeake Bay resources and habitats and to identify economic growth objectives that are consistent with manageable population growth rates and environmental protection.
PGO-02,06 PGC-02 WQO-05,11 WQC-01,03	Develop innovative approaches that provide incentives for landowners to use sound land management practices.
PGO-02,06 LRC-01	Determine the socio-economic, legal, and political implications of installation of best management practices in developing areas.

PGO-02,06 Identify current state policies and actions that reinforce the concentration of population in coastal areas, as a first step toward a better balance of coastal versus inland growth.

PUBLIC ACCESS

GOAL: Promote increased opportunities for public appreciation and enjoyment of the Bay and its tributaries.

CBA Code	Research Needs
PAO-01,02 PAC-01,02	Identify, compile, and evaluate for adequacy, in a readily accessible format, areas offering public access to and enjoyment of the Chesapeake Bay and its tributaries. Incorporating this information in a GIS format is recommended. Such areas should include: - public beaches - public landings, docks and ramps - points of historic and other special interests - unusual habitats
PAO-01,02 03,04 PAC-01	Identify, compile, and evaluate for adequacy, in a readily accessible format, additional potential areas for acquisition by local, state, and federal government's for habitat protection and public access to tidal shoreline areas of the Chesapeake Bay and its tributaries; and identify and evaluate appropriate procedures for land aquisition by such governments.
PAO-04 PIO-03,04	Develop a strategy for increasing public knowledge of environmentally sensitive areas and unique habitats while providing public access to such areas in a manner conducive to their long-term preservation.
PAC-01	Evaluate and project, by type of activity, the recreational demand on the mainstem Chesapeake Bay and individual tributaries, and determine how to meet the projected demand while limiting negative environmental impacts.
PAO-02	Identify the legal, policy, and in institutional impediments to aquaculture development geared toward commercial fisheries in the Chesapeake Bay and its tributaries .

NOTES: Emphasis should be placed on increasing low impact activities and the improving and proper managing of existing accesses and facilities.

PUBLIC INFORMATION, EDUCATION AND PARTICIPATION

Goal: Promote greater understanding among citizens about the Chesapeake Bay system, the problems facing it, and policies and programs designed to help it, and to foster individual respondsibility and stewardship of the Bay's resources.

Goal: Provide increased opportunities for citizens to participate in decisions and programs affecting the Bay.

CBA Code	Research Needs
PIO-03 PIC-01,03	Assess the current level of public knowledge of Chesapeake Bay resources, problems, and issues to aid in developing education programs.
PIO-01,03 06 PIC-02,03	Determine and/or develop an information source to facilitate regular and rapid communication of ongoing research programs and findings within the scientific community and to the general public, encouraging both peer review and public education.
NOTES:	Increased awareness and concern among the general public about the Chesapeake Bay and its living resources is critical for continued protection and management. Public education and participation is encouraged and should be supported through increased communication processes such as educational programs, informational literature, and input into Chesapeake Bay policy and programs.
PIO-03,04 05 PIC-01,03	Support student assistantship and internship program which would insure that: - graduate students pursuing research in academic and research institutions are encouraged to work jointly with appropriate management agencies and begin their professional life with such agencies. - undergraduate and high-school students participating in work-study and internship programs work on joint programs with management agencies.

GOVERNANCE

GOAL: Support and enhance the present comprehensive , coordinated approach toward the management of the Chesapeake Bay system.

GOAL: Provide for continuity of management efforts and perpetuation of commitments necessary to ensure long-term results.

CBA Code	Research Needs
GC-02	Conduct policy research on various management issues using case studies as a means for transferring the results (wetlands, shoreline use, land use management impacts on water quality).
GO-05 PGO-01	Conduct economic studies to ensure most cost effective approaches to Bay management.
GO-06 WQO-04,08	Develop a process to identify and track new activities which may have the potential to adversely impact Chesapeake Bay water quality and living resources.
GO-06	Establish a program which tracks socio-economic and environmental indicators of Bay use (possibly reinstate, with local support, the Chesapeake Bay Assessments terminated by NOAA).
GO-08,09 LRO-01,02 08	Develop a system of protected, representative sites that would be used for long-term habitat health and condition monitoring.
GO-03,07 08,09 GC-02,04 05 LRO-05,06 LRC-02,03 04,05	Inventory all ongoing monitoring programs and identify those which could contribute to/cooperate with the Baywide monitoring program.
GO-07,08 GC-02,05 LRO-01,02 05,06 LRC-01,02 03,04 05 WQO-13	Evaluate Bay-wide monitoring program for effectiveness and appropriateness; specifically address: - consistency among agencies and institutions - spatial and temporal coverage - habitat inventory

WQC-01,02

- species health and stock assessment

- appropriateness of monitoring parameters

- incorporation of new monitoring parameters (i.e., toxics, water column respiration, phytoplankton community composition and production, etc.)

- the ability of remote sensing and other technologies to enhance the information obtained through the present monitoring network (i.e., chlorophyll coverage, sediment movement, land-use patterns, etc.)

1987 Chesapeake Bay Agreement

Final Draft
December 14, 1987

1987 CHESAPEAKE BAY AGREEMENT

The Chesapeake Bay is a national treasure and a resource of worldwide significance. Its ecological, economic, and cultural importance are felt far beyond its waters and the communities that line its shores. Man's use and abuse of its bounty, however, together with the continued growth and development of population in its watershed, have taken a toll on the Bay system. In recent decades, the Bay has suffered serious declines in quality and productivity.

Representing the Federal government and the States which surround the Chesapeake Bay, we acknowledge our stake in the resources of the Bay and accept our share of responsibility for its current condition. We are determined that this decline will be reversed. In response, all of our jurisdictions have embarked on ambitious programs to protect our shared resource and restore it to a more productive state.

In 1980, the legislatures of Virginia and Maryland established the Chesapeake Bay Commission to coordinate interstate planning and programs from a legislative perspective. In 1985, Pennsylvania joined the Commission. And, in 1983, Virginia, Maryland, Pennsylvania, the District of Columbia, the U.S. Environmental Protection Agency, and the Chesapeake Bay Commission formally agreed to a cooperative approach to this undertaking and established specific mechanisms for its coordination. Since 1983, our joint commitment has carried us to new levels of governmental cooperation and scientific understanding. It has formed a firm base for the future success of this long-term program. The extent and complexity of our task now call for an expanded and refined agreement to guide our efforts toward the twenty-first century.

Recognizing that the Chesapeake Bay's importance transcends regional boundaries, we commit to managing the Chesapeake Bay as an integrated ecosystem and pledge our best efforts to achieve the goals in this Agreement. We propose a series of objectives that will establish a policy and institutional framework for continued cooperative efforts to restore and protect Chesapeake Bay. We further commit to specific actions to achieve those objectives. The implementation of these commitments will be reviewed annually and additional commitments developed as needed.

GOALS AND PRIORITY COMMITMENTS

This new Agreement contains Goals and Priority Commitments for Living Resources; Water Quality; Population Growth and Development; Public Information, Education and Participation; Public Access; and Governance.

The parties to this 1987 Agreement are the U.S. Environmental Protection Agency, representing the Federal government, the District of Columbia, the State of Maryland, and the Commonwealths of Pennsylvania and Virginia (hereinafter the "States"), and the Chesapeake Bay Commission. This Agreement may be amended and attachments added in the future by unanimous action of the Chesapeake Executive Council.

LIVING RESOURCES

GOAL: PROVIDE FOR THE RESTORATION AND PROTECTION OF THE LIVING RESOURCES, THEIR HABITATS, AND ECOLOGICAL RELATIONSHIPS.

The productivity, diversity and abundance of living resources are the best ultimate measures of the Chesapeake Bay's condition. These living resources are the main focus of the restoration and protection effort. Some species of shellfish and finfish are of immense commercial and recreational value to man. Others are valuable because they are part of the vast array of plant and animal life that makes up the Chesapeake Bay ecosystem on which all species depend. We recognize that the entire natural system must be healthy and productive. We will determine the essential elements of habitat and environmental quality necessary to support living resources and will see that these conditions are attained and maintained. We will also manage the harvest of and monitor populations of commercially, recreationally and ecologically valuable species to ensure sustained, viable stocks. We recognize that to be successful, these actions must be carried out in an integrated and coordinated manner across the whole Bay system.

OBJECTIVES:

LRO-01 o Restore, enhance, protect and manage submerged aquatic vegetation.

LRO-02 o Protect, enhance, and restore wetlands, coastal sand dunes, forest buffers and other shoreline and riverine systems, important to water quality and habitat.

LRO-03 o Conserve soil resources and reduce erosion and sedimentation to protect Bay habitat.

LRO-04 o Maintain freshwater flow regimes necessary to sustain estuarine habitats, including, where appropriate, establishing minimum in-stream flows.

LRO-05 o Develop compatible Bay-wide stock assessment programs.

LRO-06 o Develop Bay-wide fisheries management strategies and develop complementary state programs and plans to protect and restore the finfish and shellfish stocks of the Bay, especially the freshwater and estuarine spawners.

LRO-07 o Provide for the restoration of shellfish stocks in the Bay, especially the abundance of commercially important species.

LRO-08 o Restore, enhance and protect waterfowl and wildlife.

COMMITMENT: To achieve this goal we agree:

LRC-01 o by January 1988, to develop and adopt guidelines for the protection of water quality and habitat conditions necessary to support the living resources found in the Chesapeake Bay system, and to use these guidelines in the implementation of water quality and habitat protection programs.

LRC-02 o by July 1988, to develop, adopt, and begin to implement a Bay-wide plan for the assessment of commercially, recreationally, and selected ecologically valuable species.

LRC-03 o by July 1988, to adopt a schedule for the development of Bay-wide resource management strategies for commercially, recreationally and selected ecologically valuable species.

LRC-04 o by July 1989, to develop, adopt and begin to implement Bay-wide management plans for oysters, blue crabs and American shad. Plans for other major commercially, recreationally and ecologically valuable species should be initiated by 1990.

LRC-05 o by December 1988, to develop and begin to implement a Bay-wide policy for the protection of tidal and non-tidal wetlands.

LRC-06 o to provide for fish passage at dams, and remove stream blockages wherever necessary to restore passage for migratory fish.

WATER QUALITY

GOAL: REDUCE AND CONTROL POINT AND NONPOINT SOURCES OF POLLUTION TO ATTAIN THE WATER QUALITY CONDITION NECESSARY TO SUPPORT THE LIVING RESOURCES OF THE BAY.

The improvement and maintenance of water quality are the single most critical elements in the overall restoration and protection of the Chesapeake Bay. Water is the medium in which all living resources of the Bay live, and their ability to survive and flourish is directly dependent on it.

To ensure the productivity of the living resources of the Bay, we must clearly establish the water quality conditions they require and must then attain and maintain those conditions. Foremost, we must improve or maintain dissolved oxygen concentrations in the Bay and its tributaries through a continued and expanded commitment to the reduction of nutrients from both point and nonpoint sources. We must do the same for toxics and conventional pollutants. To be effective, we will develop basin-wide implementation plans for the control and reduction of pollutants

which are based on our best understanding (including that derived from modeling) of the Bay and its tributaries as an integrated system.

OBJECTIVES:

WQO-01o Provide timely construction and maintenance of public and private sewerage facilities to assure control of pollutant discharges.

WQO-02o Reduce the discharge of untreated or inadequately treated sewage into Bay waters from such sources as combined sewer overflows, leaking sewage systems, and failing septic systems.

WQO-03o Evaluate and institute, where appropriate, alternative technologies for point source pollution control, such as biological nutrient removal and land application of effluent to reduce pollution loads in a cost-effective manner.

WQO-04o Establish and enforce pollutant limitations to ensure compliance with water quality laws.

WQO-05o Reduce the levels of nonpoint sources of pollution.

WQO-06o Reduce sedimentation by strengthening enforcement of existing sediment control regulations.

WQO-07o Eliminate pollutant discharges from recreational boats.

WQO-08o Identify and control toxic discharges to the Bay system, including metals and toxic organics, to protect water quality, aquatic resources and human health through implementation and enforcement of the states' National Pollutant Discharge Elimination System permit programs and other programs.

WQO-09o Reduce chlorine discharges in critical finfish and shellfish areas.

WQO-10o Minimize water pollution incidents and provide adequate response to pollutant spills.

WQO-11o Manage sewage sludge, dredged spoil and hazardous wastes to protect the Bay system.

WQO-12o Manage groundwater to protect the water quality of the Bay.

WQO-13o Quantify the impacts and identify the sources of atmospheric inputs on the Bay system.

COMMITMENT: To achieve this goal we agree:

WQC-01o by July 1988, to develop, adopt, and begin implementation of

a basin-wide strategy to equitably achieve by the year 2000 at least a 40 percent reduction of nitrogen and phosphorus entering the main stem of the Chesapeake Bay. The strategy should be based on agreed-upon 1985 point source loads and on nonpoint loads in an average rainfall year.

by December 1991, to re-evaluate the 40 percent reduction target based on the results of modeling, research, monitoring and other information available at that time.

WQC-02 o by December 1988, to develop, adopt, and begin implementation of a basin-wide strategy to achieve a reduction of toxics consistent with the Water Quality Act of 1987 which will ensure protection of human health and living resources. The strategy will cover both point and nonpoint sources, monitoring protocols, enforcement of pretreatment regulations and methods for dealing with in-place toxic sediments where necessary.

WQC-03 o by July 1988, to develop and adopt a basin-wide implementation strategy for the management and control of conventional pollutants as required by the Water Quality Act of 1987, entering the Chesapeake Bay system from point and nonpoint sources.

WQC-04 o by July 1988, the Environmental Protection Agency, acting for the federal government, will develop, adopt, and begin implementation of a strategy for the control and reduction of point and nonpoint sources of nutrient, toxic, and conventional pollution from all federal facilities.

POPULATION GROWTH AND DEVELOPMENT

GOAL: PLAN FOR AND MANAGE THE ADVERSE ENVIRONMENTAL EFFECTS OF HUMAN POPULATION GROWTH AND LAND DEVELOPMENT IN THE CHESAPEAKE BAY WATERSHED.

There is a clear correlation between population growth and associated development and environmental degradation in the Chesapeake Bay system. Enhancing, or even maintaining, the quality of the Bay while accommodating growth will frequently involve difficult decisions and restrictions and will require continued and enhanced commitment to proper development standards. The States and the Federal government will assert the full measure of their authority to mitigate the potential adverse effects of continued growth.

Local jurisdictions have been delegated authority over many decisions regarding growth and development which have both direct and indirect effects on the Chesapeake Bay system and its living resources. The role of local governments in the restoration and

protection effort will be given proper recognition and support through State and Federal resources.

States will engage in an active partnership with local governments to establish policy guidelines to manage growth and development.

OBJECTIVES:

PGO-01o Designate a state-level office responsible for ensuring consistency with this Agreement among the agencies responsible for comprehensive oversight of development activity, including infrastructure planning, capital budgets, land preservation, and waste management activities.

PGO-02o Provide local governments with financial and technical assistance to continue and expand their management efforts.

PGO-03o Consult with local government respresentatives in the development of Chesapeake Bay restoration and protection plans and programs.

PGO-04o Identify and give public recognition to innovative and otherwise noteworthy examples of local government restoration and protection-related programs.

PGO-05o Assure that government development projects meet all environmental requirements.

PGO-06o Promote, among local, State, and federal governments, and the private sector, the use of innovative techniques to avoid and, where necessary, mitigate the adverse impacts of growth.

COMMITMENT: To achieve this goal, we agree:

o PGC-01 to commission a panel of experts to report by December 1988, on anticipated population growth and land development patterns in the Bay region through the year 2020, the infrastructure requirements necessary to serve growth and development, environmental programs needed to improve Bay resources while accommodating growth, alternative means of managing and directing growth, and alternative mechanisms for financing governmental services and environmental controls. The panel of experts will consist of twelve members: three each from Virginia, Maryland, and Pennsylvania, and one each from the District of Columbia, Environmental Protection Agency, and the Chesapeake Bay Commission.

o PGC-02 by January 1989, to adopt development policies and guidelines designed to reduce adverse impacts on the water quality and living resources of the Bay, including minimum best management practices for development and to cooperatively assist local governments in evaluating land-use and

development decisions within their purview, consistent with the policies and guidelines.

PGC-03 o to evaluate state and federal development projects in light of their potential impacts on the water quality and living resources of the Chesapeake Bay, and design and carry out each State and Federal development project so as to serve as a model for the private sector in terms of land use practices.

PGC-04 o by December 1988, to develop a strategy to provide incentives, technical assistance and guidance to local governments to actively encourage them to incorporate protection of tidal and non-tidal wetlands and fragile natural areas in their land-use planning, water and sewer planning, construction, and other growth-related management processes.

PUBLIC INFORMATION, EDUCATION AND PARTICIPATION

GOAL: PROMOTE GREATER UNDERSTANDING AMONG CITIZENS ABOUT THE CHESAPEAKE BAY SYSTEM, THE PROBLEMS FACING IT, AND POLICIES AND PROGRAMS DESIGNED TO HELP IT, AND TO FOSTER INDIVIDUAL RESPONSIBILITY AND STEWARDSHIP OF THE BAY'S RESOURCES.

GOAL: PROVIDE INCREASED OPPORTUNITIES FOR CITIZENS TO PARTICIPATE IN DECISIONS AND PROGRAMS AFFECTING THE BAY.

The understanding and support of the general public and interests groups are essential to sustaining the long-term commitment to the restoration and protection of the Chesapeake Bay system and its living resources. Citizens must have opportunities to learn about that system and associated management policies and programs and must be given opportunities to contribute ideas about how best to manage that natural system.

OBJECTIVES:

PIO-01 o Provide timely information on the progress of the restoration program.

PIO-02 o Assure a continuing process of public input and participation in policy decisions affecting the Bay.

PIO-03 o Enhance Bay-oriented education opportunities to increase public awareness and understanding of the Bay system.

PIO-04 o Provide curricula and field experiences for students.

PIO-05 o Promote opportunities to involve citizens directly in Bay

PIO-06 o. Coordinate the production and distribution of Ba
restoration efforts.
tion and education materials.

COMMITMENT: To achieve these goals, we agree:

PIC-01 o to conduct coordinated education and information programs to inform the general public, local governments, business, students, community associations, and others of their roles, responsibilities, and opportunities in the restoration and protection effort, and to promote public involvement in the management and decision-making process.

PIC-02 o to provide for public review and comment on all implemen tion plans developed pursuant to this agreement.

PIC-03 o by March 1988, to develop state and federal communica plans for public information, education, and participa and by May 1988, to develop a unified, Bay-wide comm tion plan.

PIC-04 o to promote Chesapeake Bay restoration efforts b lishing an annual Bay-wide series of Chesape Watershed Awareness events, to include a Govern Fishing Tournament.

PUBLIC ACCESS

GOAL: PROMOTE INCREASED OPPORTUNITI APPRECIATION AND ENJOYMENT OF THE TRIBUTARIES.

Interest in and commitment to the Chesapeak tributaries are greatly affected by personal co natural system. Consequently improved opportuni to the shores and waters of the system are ess awareness and support be to be maintained and in

OBJECTIVES:

PAO-01 o Improve and main access to the Bay beaches, parks forested lands.

PAO-02 o Improve opportu for recreational an ing.

PAO-03 o Secure shoreliteage to maintain oper opportunities ssive recreation.

necessary acreage to protect unique habitat and environmentally sensitive areas.

PAC-01 o **COMMITMENT:** To achieve this goal we agree:

to intensify our efforts to improve and expand public access opportunities being made available by the Federal government, the States, and local governments, by developing a strategy, which includes an inventory of current access opportunities by July 1988, which targets state and federal actions to secure additional tidal shorefront acres by December 1990 along the Bay and its tributaries.

PAC-02 o by December 1988, to prepare a comprehensive guide to access facilities and the natural resource system for the tidal Chesapeake Bay.

GOVERNANCE

GOAL: SUPPORT AND ENHANCE THE PRESENT COMPREHENSIVE, COOPERATIVE, AND COORDINATED APPROACH TOWARD MANAGEMENT OF THE CHESAPEAKE BAY SYSTEM.

GOAL: PROVIDE FOR CONTINUITY OF MANAGEMENT EFFORTS AND PERPETUATION OF COMMITMENTS NECESSARY TO ENSURE LONG-TERM RESULTS.

The cooperation necessary to sustain an effective Chesapeake y restoration and protection effort requires a formal working rangement involving the States and the Federal government. t institutional arrangement must allow for and promote volun- y individual actions coordinated within a well-defined context he individual responsibilities and authorities of each State the Federal government. It must also ensure that actions h require a concerted, ay-wid approach be addressed in com- and without duplication One f the principal functions of coordinating institut.on is develop strategic plans and ee their implementatio, base on advice from the public, the scientific community, and om user groups.

n addition, the coordinating dy must exert leadership to l public support, and it muse accountable for progress nder the terms of this agrnt. The coordinating body ntinue to be called the Cheske Executive Council. The ake Executive Council shall omprised of the Governors, or of the District of Colum the Administrator of the mental Protection Agencnd the Chairman of the ke Bay Commission. The chaship of the Council shall nnually as determined by tlncil. The term of the shall be one year. The Ad rator of the Environmen- ection Agency shall represe Federal government, and

restoration efforts.

PIO-06 o. Coordinate the production and distribution of Bay information and education materials.

COMMITMENT: To achieve these goals, we agree:

PIC-01 o to conduct coordinated education and information programs to inform the general public, local governments, business, students, community associations, and others of their roles, responsibilities, and opportunities in the restoration and protection effort, and to promote public involvement in the management and decision-making process.

PIC-02 o to provide for public review and comment on all implementation plans developed pursuant to this agreement.

PIC-03 o by March 1988, to develop state and federal communication plans for public information, education, and participation, and by May 1988, to develop a unified, Bay-wide communication plan.

PIC-04 o to promote Chesapeake Bay restoration efforts by establishing an annual Bay-wide series of Chesapeake Bay Watershed Awareness events, to include a Governors' Cup Fishing Tournament.

PUBLIC ACCESS

GOAL: PROMOTE INCREASED OPPORTUNITIES FOR PUBLIC APPRECIATION AND ENJOYMENT OF THE BAY AND ITS TRIBUTARIES.

Interest in and commitment to the Chesapeake Bay and its tributaries are greatly affected by personal contact with that natural system. Consequently, improved opportunities for access to the shores and waters of the system are essential if public awareness and support are to be maintained and increased.

OBJECTIVES:

PAO-01 o Improve and maintain access to the Bay including public beaches, parks and forested lands.

PAO-02 o Improve opportunities for recreational and commercial fishing.

PAO-03 o Secure shoreline acreage to maintain open space and provide opportunities for passive recreation.

PAO-04 o Secure necessary acreage to protect unique habitat and environmentally sensitive areas.

COMMITMENT: To achieve this goal we agree:

PAC-01 o to intensify our efforts to improve and expand public access opportunities being made available by the Federal government, the States, and local governments, by developing a strategy, which includes an inventory of current access opportunities by July 1988, which targets state and federal actions to secure additional tidal shorefront acres by December 1990 along the Bay and its tributaries.

PAC-02 o by December 1988, to prepare a comprehensive guide to access facilities and the natural resource system for the tidal Chesapeake Bay.

GOVERNANCE

GOAL: SUPPORT AND ENHANCE THE PRESENT COMPREHENSIVE, COOPERATIVE, AND COORDINATED APPROACH TOWARD MANAGEMENT OF THE CHESAPEAKE BAY SYSTEM.

GOAL: PROVIDE FOR CONTINUITY OF MANAGEMENT EFFORTS AND PERPETUATION OF COMMITMENTS NECESSARY TO ENSURE LONG-TERM RESULTS.

The cooperation necessary to sustain an effective Chesapeake Bay restoration and protection effort requires a formal working arrangement involving the States and the Federal government. That institutional arrangement must allow for and promote voluntary individual actions coordinated within a well-defined context of the individual responsibilities and authorities of each State and the Federal government. It must also ensure that actions which require a concerted, Bay-wide approach be addressed in common and without duplication. One of the principal functions of the coordinating institution is to develop strategic plans and oversee their implementation, based on advice from the public, from the scientific community, and from user groups.

In addition, the coordinating body must exert leadership to marshal public support, and it must be accountable for progress made under the terms of this agreement. The coordinating body will continue to be called the Chesapeake Executive Council. The Chesapeake Executive Council shall be comprised of the Governors, the Mayor of the District of Columbia, the Administrator of the Environmental Protection Agency, and the Chairman of the Chesapeake Bay Commission. The chairmanship of the Council shall rotate annually as determined by the Council. The term of the Chairman shall be one year. The Administrator of the Environmental Protection Agency shall represent the Federal government, and

the Chairman of the Chesapeake Bay Commission shall represent its members.

OBJECTIVES:

GO-01 o Continue to demonstrate strong, regional leadership by convening an annual public meeting of the Chesapeake Executive Council.

GO-02 o Continue to support the Chesapeake Executive Council and provide for technical and public policy advice by maintaining strong advisory committees.

GO-03 o Coordinate Bay management activities and develop and maintain effective mechanisms for accountability.

GO-04 o The Chesapeake Bay Liaison Office shall provide staff support to the Chesapeake Executive Council by providing analyses and data management, and by generating reports related to the overall program. The Implementation Committee shall provide guidance to the Chesapeake Bay Liaison Office Director in all matters relating to support for the Council and their supporting committees, subcommittees, and work groups including the development of all plans and other documents associated with the Council.

GO-05 o Examine the feasibility of joint funding support of the Chesapeake Bay Liaison Office.

GO-06 o Track and evaluate activities which may affect estuarine water quality and resources and report at least annually.

GO-07 o Develop and maintain a coordinated Chesapeake Bay data management system.

GO-08 o Continue to implement a coordinated Bay-wide monitoring system and develop a Bay-wide living resource monitoring system.

GO-09 o Develop and implement a coordinated Bay-wide research program.

COMMITMENT: To achieve these goals we agree:

GC-01 o to develop an annual Chesapeake Bay work plan endorsed by the Chesapeake Executive Council.

GC-02 o to continue to support Bay-wide environmental monitoring and research to provide the technical and scientific information necessary to support management decisions.

GC-03 o to strengthen the Chesapeake Bay Liaison Office by assigning as appropriate, staff persons from each jurisdiction and from participating federal agencies to assist with the tech-

nical support functions of that office.

GC-04 o by July 1988, to develop and adopt a comprehensive research plan to address the technical needs of the Chesapeake Bay Program, to be evaluated and updated annually.

GC-05 o by July 1988, develop a Baywide monitoring plan for selected commercially, recreationally, and ecologically valuable species.

GC-06 o by March 1988, to establish a local government advisory committee to the Chesapeake Executive Council and charge that committee to develop a strategy for local government participation in the Bay program.

GC-07 o to consider and review the feasibility of establishing an independent Chesapeake Bay Executive Board.

GC-08 o by July 1988, the Environmental Protection Agency, acting for the Federal government, will develop a coordinated, federal agency workplan which identifies specific federal programs to be integrated into a coordinated federal effort to support the restoration of the Chesapeake Bay.

By this Agreement, we reaffirm our commitment to restore and protect the ecological integrity, productivity, and beneficial uses of the Chesapeake Bay system. We agree to report in January 1989 on progress made in fulfilling the commitments in this agreement, and to consider at that time additional commitments. The implementation strategies which will be developed pursuant to this agreement will be appended as annexes, and annual reports will include an accounting of progress made on each strategy.

(Date) _____

For the United States of America _____

For the District of Columbia _____

For the Commonwealth of Virginia _____

For the Commonwealth of Pennsylvania _____

For the State of Maryland _____

For the Chesapeake Bay Commission _____